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THE BOTTOM LINE

The power sector remains especially vulnerable to natural disasters and extreme weather events exacerbated by climate change. Planning ahead and investing in resilience to mitigate climate and disaster risks in the power sector can help minimize infrastructure damage and yield savings during recovery from a natural disaster. Conducting an in-depth climate and disaster risk screening (CDRS) during the planning and preparation stages of energy infrastructure projects is a crucial first step to building resilience. Data sharing, knowledge exchange, and awareness building on CDRS can substantially improve the screening process, while also helping to bring resilience to the forefront of energy investment discussions.

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ESMAP
Energy Sector Management Assistance Program

GFDRR
Global Facility for Disaster Reduction and Recovery

Climate and Disaster Risk Screening: Making Energy Projects More Resilient

Why is it important to screen energy projects for climate and disaster risks?

Screening power sector investment projects in the planning stage is a key step in identifying resilience issues and embedding solutions in the project's design

Natural disasters and extreme weather events of various types, exacerbated by climate variability and are serious risks for the power sector. Disasters such as hurricanes, cyclones, floods, extreme rainfall, droughts, and seasons of severe heat are imposing substantial financial burdens on electric utilities and governments as they deal with service interruptions (including sustained blackouts) and the effects of those interruptions on the economy. The economic impacts of the loss of electricity service and of damage to grid infrastructure can be catastrophic in some cases, leaving millions in the dark and costing the utility billions in lost revenue and recovery and restoration expenses. Some recent examples are described below.

in late 2017, **Hurricane Maria**, one of the deadliest Atlantic hurricanes on record, damaged much of Barbuda's and Puerto Rico's electricity infrastructure. It took more than 10 months for the utility to restore full power throughout mainland Puerto Rico (Kwasinski et al. 2019). In September 2020, the United States Federal Emergency Management Agency announced that it would provide $9.6 billion—one the largest disaster relief grants in the agency's history—to repair and replace the power system affected by the hurricane (Treisman 2020). Three years after Maria, Barbuda is still working to rebuild its shattered electricity grid.

Tropical cyclones Idai and Kenneth hit Mozambique's coast just a few weeks apart in 2019, damaging an electricity transmission and distribution network that serves 570,000 people. The cost of the physical damage was estimated at $133.3 million.

Damages from the **2018 wildfires in California**, brought on by extreme temperatures and drought conditions, amounted to $30 billion, enough to cause Pacific Gas and Electric to file for bankruptcy (Helman 2018).

In 2012, **Hurricane Sandy** inflicted major damage on New York's power infrastructure, leaving 1.1 million Con Edison customers without power (Con Edison 2017). The damage prompted the utility to invest $1 billion in a storm-hardening program, which in five years has reportedly prevented more than 250,000 electrical outages.

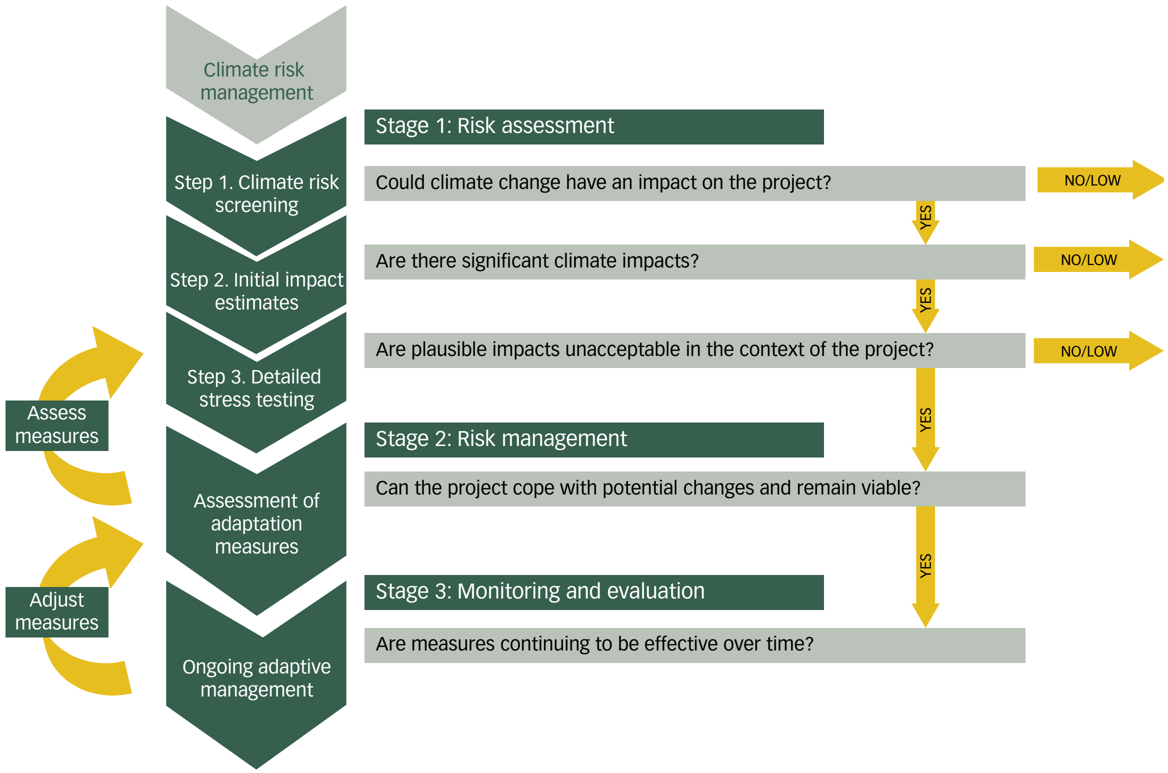
Planning ahead and investing in resilience measures to mitigate climate and disaster risks can minimize infrastructure damage and yield impressive savings during recovery from a natural disaster. Resilience measures can be particularly cost-effective if risks are identified early (during the planning stages) and measures to avoid or manage them are "designed in."

For example, a case study on integrating climate resilience in power system planning in Bangladesh found that a plan that considers flood risks when identifying locations for power-plants—avoiding sites prone to such risks and focusing instead on cross-border power trade and renewables—could save from $0.2 billion to $3.3 billion over the planning period (Mukhi et al. 2017). Reaping those savings will require a change in project methodology to explicitly recognize flood risks during the planning stage.

Other resilience measures can be considered in system planning. Transmission towers and distribution poles that are resilient to storms and conductors that can withstand heat waves can be built

CDRS is the process by which development practitioners, investors, and policy makers evaluate the degree of exposure and potential impact of climate change and natural disasters on proposed investment projects.

Figure 1. The process of managing climate risk



Source: World Bank 2019.

into the design of an investment project if the relevant risks are deemed high.

Conducting an in-depth climate and disaster risk screening (CDRS) during the planning and preparation stage is a critical first step in building resilience into plans, project design, and implementation. As one of the World Bank Group's five corporate climate commitments, CDRS is the process by which development practitioners, investors, and policy makers evaluate the degree of exposure and potential impact of climate change and natural disasters on proposed investment projects.[1] Usually a quick and simple step, CDRS identifies short- and long-term risks to development projects, policies, and programs (figure 1). It also makes it possible to determine if additional analysis through site-specific risk assessment is needed. CDRS becomes even more essential in countries that are making large investments in new energy infrastructure to increase access to electrification.

The World Bank's support for on- and off-grid projects to close the energy access gap presents an opportunity to mainstream the practice of CDRS across all new energy investments and build resilience in the power sector. To exploit this opportunity, the Bank has developed CDRS tools to allow project teams to take the first step to identify key climate and disaster risks to proposed projects.[2]

1. CDRS is required for World Bank (IDA and IBRD) operations under IDA-17, -18, and -19 policy commitments, and under the World Bank Group's Climate Change Action Plan and 2025 Targets and Actions.

2. https://climatescreeningtools.worldbank.org.

In December 2020, the World Bank Group announced that, on average, 35 percent of its financing would offer climate co-benefits over the next five years (World Bank 2020). Half of that will support adaptation and resilience. CDRS is a key step in meeting that commitment. As teams prepare project appraisal documents, they can rely on results from risk screenings and assessment of potential vulnerabilities to describe and substantiate the adaptation co-benefits of their project.

How can project teams use the Bank's CDRS tools to improve project design?

Awareness of key disaster risks and climate trends enables project managers to make informed decisions during the design of energy infrastructure projects

The World Bank developed its CDRS tools to provide a structured approach to risk assessment of proposed projects in various sectors. The tools use quality-controlled global climate data (historical and projected) to help teams make informed project design decisions. Some of the questions to which the tools provide answers are the following (Clement, Siddiqi, and Winglee 2020):

- What have been the historical trends in temperature, precipitation, flooding, and drought conditions?
- How are these trends projected to change in terms of intensity, frequency, and duration?
- Has the location experienced sea-level rise, wildfires, or geophysical hazards (earthquakes, landslides, tsunamis) that may recur?
- Given climate projections and geophysical hazards, is the location appropriate for the project?
- How can the project adapt to the risks found?

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The CDRS tools are especially valuable for infrastructure investments in the power sector, where projects may face multiple climate risks and uncertainties. For example, sites for generation plants may be prone to flooding; transmission and distribution towers and wires may be susceptible to high winds or drought-induced wildfires; and higher temperatures may affect the efficiency of solar PV and substation capacity (World Bank 2019). The only way project teams can preemptively consider and integrate measures that enhance project-level and systemwide resilience is by conducting a screening to identify:

- Potential natural hazards and climate trends that directly threaten the physical components of the proposed project—now and over its lifetime;
- Events related to climate variability and change that may reduce the performance of the project—now and over its lifetime;
- Non-physical aspects of the proposed project that may enhance or reduce the sector's adaptive capacity and affect its vulnerability.

In addition to the factors listed above, the CDRS tools enable teams to conduct a high-level qualitative assessment of external factors, such as socio-economic issues, governance and institutional capacity, and sector-wide challenges, that may raise or lower project risks.

What are the current challenges and limitations in conducting screenings?

Good screenings depend on good staff skills, good data, and, often, socio-economic data

Good skills. The Bank's CDRS tools are designed to support different user needs and levels of experience. These can range from high-level, quick overviews to more detailed projections across a wide variety of indicators, sectors, and sub-sectors. However, users should have a solid understanding of climate risks and system vulnerabilities if they are to accurately assess risks for a proposed project. A rapid or high-level CDRS may not always reveal the extent to which the project location is exposed to natural disasters, especially if the screening is conducted by someone with limited experience.

Furthermore, lack of awareness of the potential impacts of climate change on both the physical components and lifetime performance of the proposed infrastructure may also prevent project teams from using the CDRS tools optimally. In the case of the World Bank, to support teams during project preparation, each regional or subregional energy unit should ideally have two members who are

Box 1. Climate and disaster risk screening for energy sector project in Zanzibar

The World Bank is currently preparing the Zanzibar Energy Sector Transformation and Access Project, its first engagement in the energy sector of Zanzibar.[a] The purpose of the project is to finance the country's first grid-connected solar PV plant, modernize the grid, and scale up access. The grid-modernization efforts will include development of a new high-voltage transmission line; upgrades to the distribution grid; installation of a battery energy storage system; and capacity building for the utility, the Ministry of Water, Energy and Minerals, and other key stakeholders.

Exposure. The CDRS conducted for Zanzibar reveals that both islands, Unguja and Pemba, are expected to face extreme weather events and effects of climate change with increased frequency and severity. Floods and droughts have been identified as the two prominent climate risks affecting the proposed project, stemming from a projected increase in rainfall during the wet season and more frequent and severe thunderstorms. Zanzibar has experienced extreme flooding in the past and is expected to experience similar events in the future with greater intensity, frequency, and duration. Both islands have been affected by multiple droughts over the past 50 years; the assessment of the pattern of precipitation indicates that the number of dry days is expected to increase.

Impact and resilience. The climate risks that have been identified could have a significant impact on the proposed project. For example, more-frequent flooding could compromise the distribution network's tower and pole foundations and damage the solar PV farm (through erosion). Drought, extreme heat, and dust spread by wind could lower solar panel output by up to 20 percent and increase the risk of panel hotspots, limiting their performance. Given the level of exposure and potential impact on project performance, the project team will account for these risks in the technical design of physical components and integrate resilience into the technical assistance and capacity building components aimed at enabling the utility to improve its operation and maintenance practices.

Challenges and next steps. One of the key constraints during the CDRS was the limited high-resolution climate data available for Zanzibar. In some instances, the screening had to be based on data for mainland Tanzania, particularly coastal areas close to Zanzibar, to get the best possible estimates of risk exposure for the two islands. The project team will conduct a site-specific climate risk assessment (focusing on flood risk) to ensure that project design decisions are based on the best available data.

Source: World Bank 2019; climate data from Climate Change Knowledge Portal (https://climateknowledgeportal.worldbank.org/) and ThinkHazard! (https://thinkhazard.org/en/).

a. https://projects.worldbank.org/en/projects-operations/project-detail/P169561.

The quality of the CDRS for a proposed project in a particular location depends to some extent on the quality of climate data available for that location. The World Bank's CDRS tools draw on multiple quality-controlled climate data sources.

proficient with the CDRS tools and well-versed in climate risk and vulnerability of energy infrastructure. These team members help screen proposed projects, conduct feasibility studies, and liaise with global facilities to identify resources for integrating resilience in planning and design stages.

Good data. The quality of the CDRS for a proposed project in a particular location depends to some extent on the quality of climate data available for that location. The World Bank's CDRS tools draw on multiple quality-controlled climate data sources. One of these is the Bank's Climate Change Knowledge Portal (CCKP), which provides 1° x 1° gridded data (100 kilometers square) for historical and future climate projections at national, regional, and watershed aggregation scales.[3] The portal includes dynamic map presentations to demonstrate change over both spatial and temporal scales. It also allows users to select a geo-location so as to extract information (and downloadable data) for that location from the gridded data. Another source is ThinkHazard!, which provides information into current country hazard contexts at subnational scale.[4]

Although the CCKP and ThinkHazard! are excellent resources, even greater granularity of climate data would improve screenings for energy infrastructure projects, where information for a very specific location is often needed. Additionally, key climate indicators useful for energy assessments—surface wind, surface radiation (long and short-wave fluxes), and surface pressure—are currently not robust enough for deployment at global scale.[5]

These challenges become even more apparent when evaluating projects in small-island nations such as Zanzibar (see box 1 for a case study) and when dealing with extensive transmission and distribution projects, where country-level climate data may not be representative of some of the locations or topographies within the

3. https://climateknowledgeportal.worldbank.org/.

4. https://thinkhazard.org/en/.

5. New global climate models (CMIP6) are expected to be released following peer review in summer 2021. If they prove sufficiently robust at global scale, they will be incorporated into the CCKP.

Project teams may consider going beyond risk screening to conduct an on-site climate risk assessment, particularly for projects in areas that have experienced severe disasters in the recent past.

project's geographic boundaries. In such cases, project teams may have to consult national hydrological and meteorological agencies for historical data covering the project area. Depending on the level of investment under consideration and the costs of rebuilding, project teams may also consider going beyond risk screening to conduct an on-site climate risk assessment, particularly for projects in areas that have experienced severe disasters in the recent past.

With these caveats, a basic CDRS is still worthwhile as a first-cut assessment of potential risks. Even if such risks are not fully quantifiable, the screening can help identify projects clearly at high risk and warranting more detailed analysis to determine project feasibility.

Integration of socio-economic data into climate models. Many power sector investment projects have long lifespans, locking in policy and planning decisions for three to four decades. The uncertainties in forward-looking climate data make it challenging to evaluate exposure and potential impacts in the long term, which in turn makes it difficult to value the cost and benefit of integrating resilience into the proposed project. The heightened uncertainty associated with projects with long lifespans can potentially be mitigated by investments that improve the adaptive capacity of the sector in general. Fortunately, several ongoing research initiatives have focused on improving the ability of global climate models to integrate socio-economic data into global climate models, thereby improving the accuracy and utility of climate risk screenings (Evans and Hausfather 2018).

How can we improve the CDRS process?

Sharing knowledge and data can significantly improve the screening process while also encouraging investments in resilience

To optimize the CDRS process, all available data and resources must be readily accessible to project teams. A one-stop repository of essential climate data (as well as past risk screenings that specifically address risks faced by energy projects) will reduce the amount of time teams must spend on screening while also creating a platform for sharing valuable resources among teams across sectors.

Data sharing becomes even more important in cases where project teams conduct site-specific climate risk assessment or apply downscaling methods to improve spatial resolution. Sharing can save time and money for future infrastructure projects proposed in the same location. The repository may also include previous case studies and methodologies compiled to incorporate CDRS results into project design.

Beyond data sharing, exchanging knowledge and building awareness about CDRS can advance the screening process and bring resilience to the forefront of infrastructure investment discussions. Active engagement with country clients on climate risk screening and vulnerability assessments will also improve the quality of screenings, particularly in cases where project teams must work with national agencies to obtain historical climate data. Knowledge-sharing and dialogue on climate risk exposure and vulnerabilities in the energy sector can also help project teams obtain client buy-in on resilience measures. In low-income countries with limited resources and competing development priorities it may be particularly challenging to persuade governments or utilities to invest in costlier options based on a probabilistic analysis of climate impacts. Building awareness about CDRS and resilience at high levels of government may help boost commitments on resilience at the project level.

Development agencies, including the World Bank, are facilitating knowledge sharing and capacity building on climate risk and resilience. The World Banks' Global Facility for Disaster Reduction and Recovery (GFDRR) houses a knowledge hub on resilience and disaster risk management to facilitate knowledge and data sharing and help development practitioners understand the value of building resilience.[6] The Bank's "Good Practice Note for Energy Sector Adaptation" (World Bank 2019) outlines the direct and indirect impacts of climate change on all segments of the power sector, including renewable generation. The CCKP team has developed multiple resources and guidance documents to support project teams conducting screenings (box 2) and is constantly working to update and improve the information, visualizations, and applications available to project teams. Climate data are also continuously updated to reflect the most recent global datasets.

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6. https://www.gfdrr.org/en/knowledge-hub.

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Live Wire 2015/43. "Integrating Climate Model Data into Power System Planning," by Debabrata Chattopadhyay and Rhonda L. Jordan.

Live Wire 2016/59. "Are Power Utilities in Tonga and New Zealand Resilient? : Human and Organizational Factors in Disaster Response," by Ray Brown, Xiaoping Wang, and Christopher Page.

Live Wire 2016/60. "Toward Climate-Resilient Hydropower in South Asia," by Pravin Karki, Laura Bonzanigo, Haru Ohtsuka, and Sanjay Pahuja.

Live Wire 2017/84. "Disaster Preparedness Offers Big Payoffs for Utilities," by Samuel Oguah and Sunil Khosla.

Find these and the entire Live Wire archive at www.worldbank.org/energy/livewire.

Recommended next steps for World Bank project teams are:

- Explore the various climate data and risk screening resources available.
- Discuss CDRS within regional and subregional energy units and outline possible ways to streamline the screening process during project preparation, including identifying dedicated staff well-versed in climate and disaster risk and the vulnerability of energy infrastructure.
- Engage with country clients to identify opportunities to build awareness about CDRS and the importance of considering resilience when planning infrastructure investments.

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Box 2. CDRS resources available to World Bank project teams

- CCKP Climate Meta Data
- CCKP Tutorial Videos
- Climate Risk Country Profiles
- CCKP Energy Sector Dashboard

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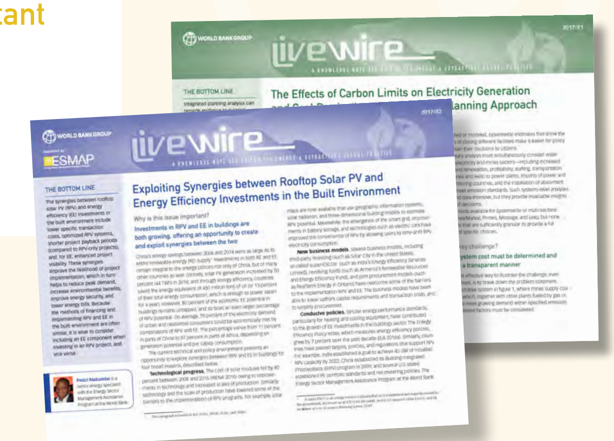

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